**Heuristic Analysis**

Analysis of evaluation functions are performed by observing 3 test runs shown in Illustration 1-3. The detail of evaluation functions used is as follows:
- AB_Improved: h = num_player_moves – num_opponent_moves
- AB_Custom: h = num_player_moves – m * num_opponent_moves (where (1, m) where m = 2 is used)
- AB_Custom_2: h = n * num_player_moves – num_opponent_moves (where (1, n) where m = 2 is used)
- AB_Custom_3: h = n * num_player_moves – m * num_opponent_moves (where (1, m) and (1, n) where n = 2 and m = 3 is used)

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                    *************************
                         Playing Matches
                    *************************

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random      8  |   2    10  |   0    9  |   1    9  |   1
   2       MM_Open     6  |   4     7  |   3    7  |   3    7  |   3
   3      MM_Center   10  |   0     8  |   2    9  |   1    9  |   1
   4     MM_Improved   7  |   3     9  |   1    7  |   3    7  |   3
   5       AB_Open     6  |   4     5  |   5    5  |   5    6  |   4
   6      AB_Center    5  |   5     4  |   6    3  |   7    4  |   6
   7     AB_Improved   5  |   5     6  |   4    7  |   3    4  |   6
-----------------------------------------------------------------------
          Win Rate:      67.1%        70.0%        67.1%        65.7%
```

*Illustration 1*

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                    *************************
                         Playing Matches
                    *************************

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random      8  |   2    10  |   0    9  |   1    10 |   0
   2       MM_Open     7  |   3     8  |   2    10 |   0    7  |   3
   3      MM_Center    9  |   1    10  |   0    10 |   0    9  |   1
   4     MM_Improved   6  |   4     7  |   3    8  |   2    6  |   4
   5       AB_Open     6  |   4     3  |   7    5  |   5    5  |   5
   6      AB_Center    6  |   4     6  |   4    4  |   6    6  |   4
   7     AB_Improved   6  |   4     3  |   7    5  |   5    4  |   6
-----------------------------------------------------------------------
          Win Rate:      68.6%        67.1%        72.9%        67.1%
```

*Illustration 2*

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                    *************************
                         Playing Matches
                    *************************

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random      9  |   1    10  |   0    9  |   1    8  |   2
   2       MM_Open     9  |   1     8  |   2    6  |   4    8  |   2
   3      MM_Center   10  |   0     9  |   1    7  |   3    8  |   2
   4     MM_Improved  10  |   0     7  |   3    8  |   2    5  |   5
   5       AB_Open     4  |   6     5  |   5    5  |   5    5  |   5
   6      AB_Center    7  |   3     5  |   5    5  |   5    5  |   5
   7     AB_Improved   5  |   5     5  |   5    5  |   5    3  |   7
-----------------------------------------------------------------------
          Win Rate:      77.1%        70.0%        64.3%        60.0%
```

*Illustration 3*

From observation we can see that minimax with alpha beta and iterative deepening beats normal minimax by considerable margin regardless the evaluation function used. That is expected, since by performing iterative deepening, the algorithm can explore for more successors within the time constraint.

By comparing the result of 4 different evaluation functions against test agent, we can assume that AB_Custom is generally better to be used with iterative deepening since the decision can be more aggressive/punishing than the other evaluation functions. Though from the test result, the AB_Improved (less aggressive) can perform neck and neck with AB_Custom. The proposed AB_Custom is recommended to be used as evaluation function because of following reasons:

- It can yield better result compared to other evaluation functions given that it can make more aggressive moves especially in early state
- It yields stable performance especially compared to AB_Improved function
- The calculation is simple, comparable with other evaluation functions